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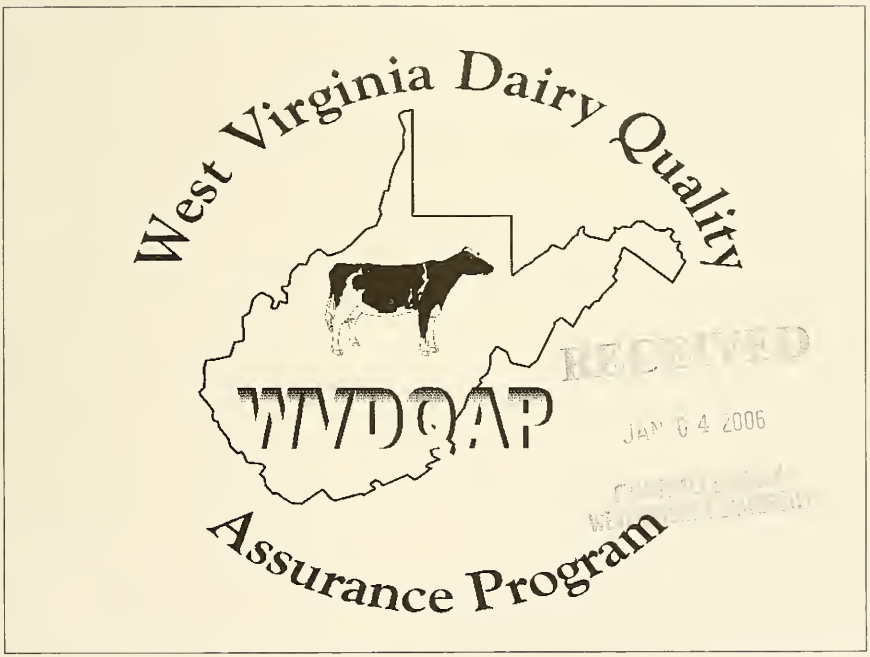
West Virginia Dairy Quality Assurance Program

By
Daniel H. Poole, Steve B. Miller, Phillip L. Osborne,
Robert E. Pitts, and Robert A. Dailey



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Acronyms used in this report:

APHIS	Animal Plant Health Inspection Service
BQA	Beef Quality Assurance
BSE	Bovine Spongioform Encephalopathy
CD	Compact Disk
DHI	Dairy Herd Improvement
DQA	Dairy Quality Assurance
FDA	Food and Drug Administration
FSIS	Food Safety and Inspection Service
HACCP	Hazard Analysis Critical Control Point
NMPF	National Milk Producers Federation
NYSCHAP	New York State Cattle Health Assurance Program
SOP	Standard Operating Procedures
USDA	United States Department of Agriculture
WVAFES	West Virginia Agricultural and Forestry Experiment Station
WVDA	West Virginia Department of Agriculture
WVDQA	West Virginia Dairy Quality Assurance
WVDQAP	West Virginia Dairy Quality Assurance Program
WVES	West Virginia Extension Service
WVU	West Virginia University

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Abstract

Consumer confidence in product quality and safety impacts viability of agricultural markets. Many food industries have adopted cost-effective programs to reduce risk and offer third party verification of product quality. The purpose of this project was to implement the West Virginia Dairy Quality Assurance Program (WVDQAP) to promote best management practices to produce high quality milk and meat products. This study surveyed dairy producers throughout the state to establish the most effective method of program implementation. A manual was constructed and presented to producers at each of five meetings across the state. This manual focused on the requirements a producer must fulfill to receive certification as a producer of quality dairy milk.

Introduction

Potential threats of bio-terrorism, transmission of diseases from animals to humans and a sense of urgency for ensuring bio-security underscore the importance of food safety to American consumers. Payne et al. (1) suggested that a verified program would demonstrate an industry commitment to the consumer that safe, wholesome food is produced. Through voluntary adoption of industry-generated guidelines (2), the beef and pork industries have shown that self-regulation is an important aspect of building consumer confidence. Dairymen need to counter incorrect information on product safety, nutritive value, and production standards propagated by special interest groups whose goals are anti-agriculture. Although small (less than 20,000 cows), West Virginia's industry generates 40 million dollars per year and contributes significantly to agriculture and tourism industries, as well as the rural life style. In West Virginia, 95.4 % of dairy farms are family or individually owned, typically milking fewer than 200 cows on an average of 172 acres. As in other states, the number of farms (3.3%) and milk cows (19.2%) decreased over the past five years, while number per herd and pounds of milk produced (32.6 %) per herd increased (3). In 1997, six counties (Jefferson, Mason, Berkeley, Preston, Greenbrier, and Monroe) had more than 70% of the milk cows (4). Fewer than 100 herds in West Virginia are enrolled in Dairy Herd Improvement (DHI). Dairy producers in West Virginia lack an industry-wide program of voluntary self-regulation and therefore need a system to assure consumers of the quality and safety of dairy products. Viability of the industry in West Virginia depends on the competitiveness and marketability of products produced by those small operations and assuring dairy quality would enhance competitiveness and marketability.

Educational initiatives by West Virginia dairymen are integral to implementation of a dairy quality assurance program. Other states, for example New York (New York State

Cattle Health Assurance Program, NYSCHAP, 5), have dairy quality programs to assess risks in dairy production. Through the involvement of the West Virginia Department of Agriculture (WVDA), West Virginia Agriculture and Forestry Experiment Station (WVAFES), West Virginia Extension Service (WVES), and National Milk Producers Federation (NMPF), a West Virginia dairy quality assurance program (WVDQAP) was developed. The goal of the WVDQAP was to help prevent, eliminate or reduce three types of hazards (6):

Biological – viruses, bacteria, parasites, fungal contaminants, infectious or contagious agents.

Chemical – drug residues, pesticides, herbicides, feed additives, and environmental toxicants.

Physical – facilities, equipment, animal handling, or animal treatment methods.

This program is designed to encourage producers to formulate and implement practical farm plans to improve and maintain consistency and quality of their products.

Methodology

Three broad goals were met to implement the WVDQAP.

1. *Establish a WVDQA committee.* This committee provided guidance and oversight and was responsible for addressing needs of dairy producers and concerns of consumers. The West Virginia Commissioner of Agriculture appointed representatives from State regulatory (WVDA), outreach (WVES), and educational (WVAFES) branches. In addition, industry partners (NMPF) and dairy producers were members of the committee to facilitate co-operation.

2. *Develop the WVDQAP.* Collaboration between WVU and WVDA was established to develop the WVDQAP. Similar quality assurance programs in Pennsylvania (7), New York (8) and California (9) were used to construct a manual that provides producers a self-instructional method of incorporating best management practices into their dairies and to identify animal health, consumer, and food safety issues. The completed manual was published and distributed to producers during educational presentations. Participating producers received the WVDQAP certification after completing the requirements established by the WVDQA committee.

3. *Deliver the WVDQAP.* Different modes of delivery were adopted: oral presentations, compact discs, and informational sheets.

a. *Survey.* A survey was constructed to evaluate producer knowledge of dairy quality assurance and preferred method of program presentation. The first part of the questionnaire related to quality assurance programs and impressions of consumer impact on agricultural production. The next section measured producer preference for learning methods. The last section identified producer computer usage and type of encouragement that would influence participation in the program. The survey was anonymous; inclusion of personal information was optional.

b. *Producer Education Program.*

West Virginia Dairy Quality Assurance Program Survey

1. What effect do quality assurance programs have on consumption of dairy products?

   High Medium Low

2. Is third party verification for quality assurance needed in the dairy industry?

   Yes or No

3. Are you aware of any quality assurance programs focused toward the dairy industry?

   Yes or No

   If so, which ones? _____

4. Would you be willing to participate in a voluntary dairy quality assurance program?

   Yes or No

5. Which is your preferred method in learning about dairy quality assurance?

   ___Face-to-face presentation ___Instructional CD ___Web delivery other _____

6. When is the most convenient time for you to participate in educational programs?

   Select seasons: winter – spring spring – summer summer – fall fall – winter

   anytime

   Select time: morning afternoon evening anytime

7. What would encourage you to participate in dairy education presentations and related seminars?

   ___Interesting topics ___Free dinners ___Door prizes ___Free agricultural-related materials

   other _____

8. Do you have a computer? Yes or No

   If not, do you have access to a computer? Yes or No

   If so, where is it located? ___Home ___Office other _____

9. Rank the following in order of interest to you? (1 is highest interest, 4 is lowest interest)

   ___Decrease Mastitis ___ Improve Production ___Reduce Johne's Disease

   ___Improve Reproduction other _____

Personal Information (Optional):

Name: _____ Date: _____

Address: _____

Phone Number (___)___-_____ Email Address_____

i. *Development* An educational program for producers, veterinarians, and suppliers/distributors of animal health care products was developed as a Microsoft PowerPoint© presentation. Resource materials were generated from continuing educational meetings, industry materials, WVU and National Agricultural Libraries, and the Internet. Educational programs had three primary elements:

Johne's educational program. A WVDA veterinarian, using educational material from the National Johne's Center, led discussion on surveillance through herd testing.

Mastitis awareness program. WVAFES personnel, using educational material from the National Mastitis Center, led discussion on prevention and treatment of mastitis.

Risk assessment. WVAFES personnel led discussion on NYSCHAP and use of economic worksheets from the University of Maryland.

ii. *Delivery* Face-to-face presentations were used to summarize the importance of quality assurance and producer certification. Meetings were coordinated through WVES county agents for mid-June in areas with the largest concentrations of dairies in West Virginia (10). The agenda included a meal followed by presentations encompassing an overview of the WVDQAP, the WVDA Johne's program, animal identification, dairy-beef quality assurance, and cost of production analysis. Importance of quality assurance, consumer concern, and the ease of obtaining certification via implementation of the producer manual were stressed. Other presentations were given at the WV State Dairy Show and the WV State Fair. In addition, a single page document was developed as a handout and copies of the computer presentation were made available to extension, dairy, and educational personnel as well as individual producers.

Program Evaluation. Overall objectives (Table1) were derived to achieve goals established for the WVDQAP. Selected producers, internal professionals and extension personnel evaluated the WVDQAP manual. Survey data were analyzed by Data Access© to ascertain the best guidelines for meetings and for assessment of producer knowledge and willingness to participate. Meeting effectiveness was determined through attendance records and type of attendees, and feedback of the attendees on the quality of the presentations including material presented, mode of presentation and the presenters. Utility of the program for the producers was the major item assessed.

Results

1. The WVDQA Committee: The Commissioner of Agriculture appointed a committee composed of two dairy producers, and WVES, WVDA, and WVU personnel. The committee ruled that producers should implement Hazard Analysis Critical Control Points (HACCP) modules in participating in the program. The procedure for becoming part of the program involved these steps:

- Producer requests enrollment in the West Virginia Dairy Quality Assurance Program with the State Veterinarian's Office.

Table 1 Goals for Establishing the WVDQA	
Goal 1.	*Assess Need For The Program*
	Collect library research
	Conduct analysis of problem
	Develop varied proposals to alleviate the problem
	Presentation of assessment to State Dairy Quality Assurance Board
	Presentation of proposals to State Dairy Quality Assurance Board
Goal 2.	*Prepare Outreach Program*
	Continue library research
	Establish contacts with model programs in Pennsylvania and New York
	Synthesize Power-Point Presentation of need for Dairy Quality Assurance
	Make presentations locally
Goal 3.	*Prepare Draft Manual for West Virginia Dairy Quality Assurance*
	Collect information for the manual
	Collate material
	Develop procedures for delivery
	Construct draft manual
	Present to the State Dairy Quality Assurance Committee for suggested changes
	Obtain approval by the State Dairy Quality Assurance Committee for final manual
Goal 4.	*Deliver the Program*
	Assess avenues for delivery
	Meet with personnel to plan a delivery format
	Develop a mechanism for delivery
	Deliver the program
Goal 5.	*Institute the Program*
	Publish the final manual
	Establish rules for assurance
	Solicit enrollees
	Assess the overall program

- Producer has premise identification and has animals listed in the national animal identification program or agrees to institute the national animal identification program.
- The State Veterinarian or proxy arranges and conducts a risk assessment of the herd with the producer.
- The producer and State Veterinarian or proxy develop a specific herd plan designed to improve the operation's best management practices.

2. Develop the WVDQAP: The manual consisted of two major sections entitled Producer Requirements and Resource Information/Appendix. The producer requirement section listed the requirements for certification. A producer had to complete the following sequential procedures to receive certification.

- Complete an initial agreement to implement the ideals of the quality assurance program.
- Perform a step-by-step analysis of their animals, facilities, and operating procedures to determine specific problems that need addressed.
- Keep accurate records and written standard operating procedures.
- Conduct a risk assessment of their operation and construct a farm specific herd plan focusing on specific goals for the upcoming year.
- Comply with the 1997 FDA feed ban.
- Incorporate and enhance dairy beef production on their operations.

The second section contained facts and figures important to the dairy industry. This section was supplemental to assist the producer with any questions that he/she may have on HACCP, general farm biosecurity, recommended milking procedures and methods of mastitis control, medicines and withdrawal times, common bovine diseases, evaluation of body, udder, and cleanliness scores and cattle condition, manageable culling practices, and additional record forms for barn usage. By completing the forms sequentially in the manual, producers exceed the minimum requirements. Descriptions of the forms follow:

Application/Agreement This is the primary agreement among the producer, his/her veterinarian, and WVDA and includes all descriptive information required about the participating farm and producer. Minimum requirements include proper animal identification, accurate record keeping, and standard operating procedures. The producer works through a checklist to achieve first level certification in the WVDQAP. Once a task is completed, it is initialed and dated. By the end of the first year, this checklist should be completed to enable the producer to proceed to level two.

Baseline Survey The purpose of the survey is to identify overall farm concerns, as well as record herd inventory and current health programs. This form established a framework for the owner, advisor, and other essential people involved with the dairy.

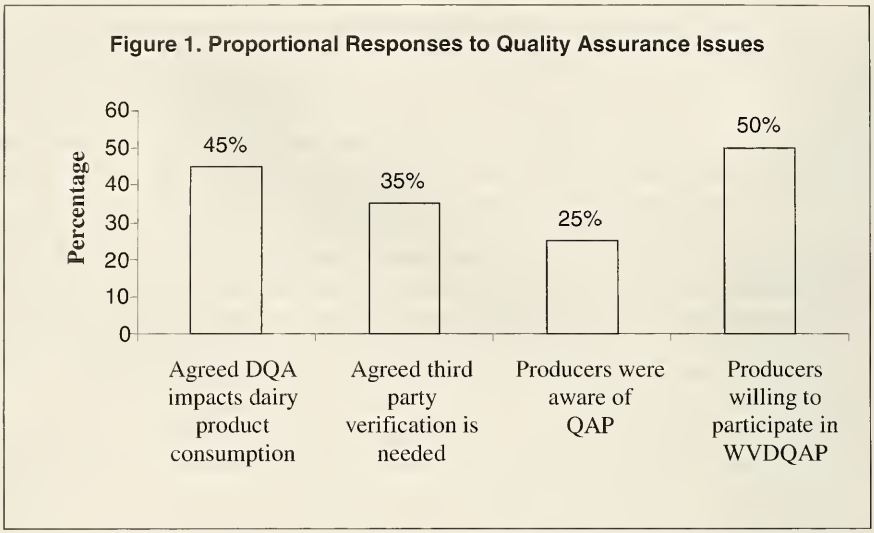
Record/Forms Animal identification records should include all lactating and dry cows, heifers, cull cows, and calves. A drug inventory should list all pharmaceutical and biological medications, vaccinations, and any other medicinal substances given to animals, including purchase and expiration dates. Treatment records must list the treatment given, animal number, and date. Example record keeping systems commonly used on dairies are provided.

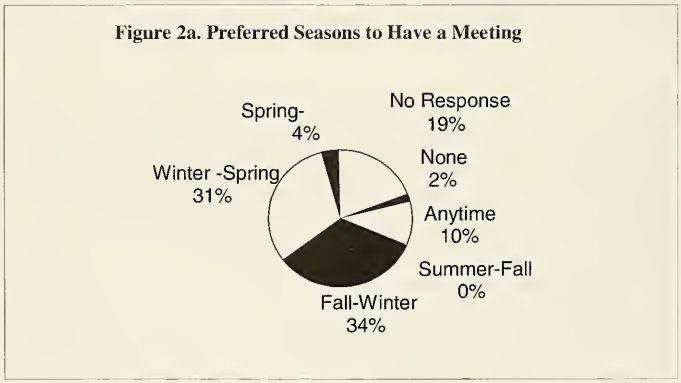
Standard Operating Procedures (SOP's) Standard operating procedures combine planned training and regular performance comments. When written well, SOP's provide direction, improve communication, reduce training time, and improve work consistency. The Pennsylvania State Extension Service gave the WVDQAP approval to include its guide for writing SOP's. Sample sheets are included to demonstrate treatment plans. The WVDQAP requires that producers maintain written SOP's that inform all employees of the correct procedures for milking, feeding and treatment of animals.

Area Risk Assessment This section identifies risks from biological, physical and/or chemical hazards within each management area. Animals are grouped into areas: calving/maternity, neonates/ pre-weaned, post weaned/ heifer rearing, dry and pre-fresh cows, lactating cows, sick/treated/hospitalized cows, and purchased or re-entering cows. A quick reference guide focuses on biosecurity, facilities, feed/bunker/pasture management, manure disposal, quality assurance, and water resources. The quick reference guide and risk assessment tables contain examples of specific problems that could occur.

Herd Plan This section contain a cover page and herd plan charts. The cover page briefly identifies the goals of the dairy and the priority for each goal. The charts aid the producer in establishing the plan. The charts are designed to list the various steps required to reduce specific risks. They also place responsibilities on certain people and/or groups as well as labeling how and when tasks should be completed. Each herd plan is farm specific, is developed by the producer and his/her veterinarian, summarizes all accomplished objectives, and enumerates specific goals for the upcoming year. After completion of the herd plan and the other requirements, the dairy will be certified as a level one dairy in the WVDQAP.

3. Delivery *a. Survey Results* A total of 180 surveys were distributed and approximately 29% were completed and returned. Five dairies were no longer in business. Responses (Figure 1.) showed varied awareness of quality assurance programs from somatic cell counts and other processing requirements to actual quality assurance programs, such as Pennsylvania DQA.

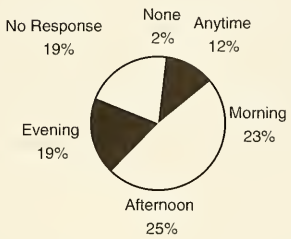




To examine the most effective way to present the program, questions were asked pertaining to meeting types, time of day, season, and type of encouragement needed for attendance. Overwhelmingly, producers preferred afternoon, face-to-face presentations in fall through spring (Figures 2a and b). Many stated that they would attend as long as topics were of interest to them. Fifty- six percent has access to a computer primarily in their homes. The final question on the survey asked the producers to rank their interest in topics on decreasing the incidence of mastitis, increasing production, and reducing Johne's disease. Thirty-eight percent of producers was interested primarily in decreasing mastitis and

improving production. Reduction of Johne's disease ranked very low, underscoring that it was not perceived as a threat. Although familiar with most new information, producers were not aware of with many newer concepts. Two problem areas that arose were lack of participation of dairy producers in Johne's disease testing programs and a general indifference towards the issue of dairy-beef.

Figure 2b. Preferred Time for a Meeting



3 b. Educational Program Approximately 23% of West Virginia's dairy producers and some producers from Pennsylvania and Maryland attended. Other attendees were from Dairy Farmers of America, WVDA, WVES, and WVU. Producer participation varied (Table 2.). Initial presentations were on rainy days. The later meetings were on more favorable days, and producers were more likely to stay home and work.

Table 2. The WVDQAP Regional Meetings

Meeting Regions	Number of Producers	Total Attendees
West	3	9
North	15	20
Central	12	19
East	6	11
South	5	11
Total	41	70

Discussion

Leaders from WVDA, WVAFES, WVES, and NMPF met in May 2001 to discuss the future of the dairy industry in West Virginia. The Director of Animal Health and Farm Services of NMPF concluded that producers who do not take an active role to bolster herd health and consumer confidence may find themselves out of business as the burden of increasing regulation rises in response to actions of activist groups in the absence of voluntary self-monitoring in the industry. The need for unification in self-monitoring by the dairy industry places increased responsibility on WVDA and WVES personnel to see that accurate, current information is distributed to the producer. Over the last 20 years, the number of WVES dairy specialists has dwindled from two to none. Artificial breeders, dairy nutritionists, and veterinarians are the primary individuals who provide important, pertinent, and timely information. Usually, the information is focused and problem specific for a single producer (11). As found in a previous study (12), the majority of WV producers have electronic access to information. Although much information is available through the Internet, as well as dairy publications, the survey showed that producers prefer face-to-face contact. However, meetings have to be convenient for dairy producers to attend. Enrolling producers in implementing best management practices for mastitis resulted in sustained adoption by the producers and economic improvements in milk quality (13). However, regular meetings and discussions were critical to acceptance. Delivery of timely and relevant information to WV producers is problematic.

Food producers and processors realize the impact that consumers have on agricultural markets. Standardized procedures and written records are necessary to assure consumers that local dairy farmers are producing products that are safe and nutritious. In response to consumer inputs, many food industries have adopted programs that provide cost-effective ways of reducing risks and offer verification of product quality (14). However, these cost effective ways have been to comply with Megaregs (15) instituted by USDA. West Virginia is one of many states implementing programs that promote the use of best management practices on dairy farms (16). In Pennsylvania (17), outside individuals (extension agents, feed representatives, inspectors), working with a producer, decreased the risk of drug residues in milk by 19%. However, herds that had prior residue problems required individual hands-on contact with producers to reduce risk. Capability of dairy producers in making informed decisions should be enhanced by the WVDQAP.

Two problem areas identified at meetings in the current study were 1) the lack of participation of dairy producers in Johne's disease testing programs and 2) a general apathy toward dairy-beef. This lack of awareness of these elements of profitability, and thus sustainability of the industry, indicates a lack of knowledge of HACCP and its role in ensuring a wholesome, healthful food (18). However, on-farm HACCP programs are difficult to implement and manage (19) and alternatives, such as hurdle technology (20), are likely to be more readily used. Herd managers are aware of traditional diseases affecting

dairy cattle, and, in general, have established preventive medicine protocols to minimize infections. National Animal Health Monitoring Service (21) has shown a higher incidence of Johne's disease in dairy cattle than in beef cattle. Johne's disease, or paratuberculosis (22), is a chronic disease of ruminants that causes thickening of the gastrointestinal lining, reduces nutrient absorption, and results in lowered production that costs an estimated $22 per head in the United States (22). Although a definitive relationship (e.g. 23,24) of Johne's with Crohn's disease in humans has not been established, dairy producers need to minimize risks of transmitting diseases from animals to humans. The WVDA has an initiative to identify cattle herds infected with Johne's disease. This project involves enrollment of primarily beef producers in testing animals and certification of herds as Johne's-free. One outcome has been that the Southern West Virginia Bull Test Station established that only animals certified as free of Johne's disease are allowed in the test program. By identifying producers whose practices pose a potential risk to animal and human health, better management practices can be designed (25,26) to eliminate, or at least minimize, the negative effects that those producers might have on the industry as a whole. A portion of the Johne's intervention program and the WVDQAP is on-farm risk assessment of the farm, a component of a HACCP plan. However, few West Virginia dairy producers participated in the Johne's testing program.

The other problem area also is relevant to production of wholesome foods derived from dairy operations. Dairy-beef represents 20-30% (27) of the beef marketed in the United States and has become important to many fast food restaurants and bargain steak houses. Selection for milk production has resulted in cattle breeds that are thought of as single purpose, dairy, with the exception of the veal calf market. But, spent cows, lame cows, and cows with mastitis can end up in the food chain. Usually these animals have been treated with antibiotics by injections in the rear quarters (27), because of ease of delivery in the milking parlor, which results in condemnation of much of the potentially edible tissue (28). Although infrequent, antibiotic violations occur more often in dairy carcasses than beef (28). The West Virginia BQA Program has educated beef producers, who readily adopted best management practices to ensure quality beef products. In fact, the West Virginia program was a model for the Mid Atlantic BQA Program that provides producers a united voice. Many infractions by dairy producers impact all animal agriculture. As an example, bovine spongioform encephalopathy (BSE) was first isolated in dairy cattle but had a devastating effect on the beef industry. Increased fear of BSE caused consumers to scrutinize animal agriculture and that triggered regulations and trade issues affecting beef and dairy producers in the United States and Canada. A program is needed to educate West Virginia dairy producers on the contribution of dairy cattle to the national beef market. Other institutions, such as the AVMA Professional Liability Insurance Trust (29), have shown interest and support the development of quality assurance programs. The AVMA Professional Liability Insurance Trust encourages development of strong relationships between producers and veterinarians during the implementation and risk assessment process for production of high quality commodities.

Summary

West Virginia is one of many states that are implanting programs that promote the use of best management practices on dairy farms. Producers involved in the WVDQAP implement standard operating procedures that target proper animal identification, record keeping, compliance with the FDA feed ban, and enhance dairy-beef quality. Approximately 50 percent of WV dairy producers are willing to participate in a quality assurance program. Although turnout at educational programs varied, approximately 20% of West Virginia's dairy producers took advantage of the opportunity. Producers were familiar with most new information, but they were not familiar with many newer concepts. Attending producers realized the impact consumers have on their industry. As industry and consumer trends change, dairies must evolve to meet their demands. Producer acceptance and participation will determine the outcome of quality assurance programs and industry viability. Participation in this voluntary, self-regulated program enables dairy producers to ensure that high quality, wholesome products are produced, thus increasing consumer faith, and ensuring West Virginia's dairies will remain profitable and sustainable for future generations.

References

1. Payne, M., C.M. Bruhn, B. Reed, A. Scearce, and J. O'Donnell. 1999. On-Farm Quality Assurance Programs: A Survey of Producer and Industry Leader Opinions. J. Dairy Sci. 82: 2224-2230.
2. Kla, J., and L. Tollefson. 1999. Producer Quality Assurance Programs. Veterinary Clinics of North America: Food Animal Practice 15 (1): 197-208.
3. Abbe, D., and S.R. Edwards. 1997. West Virginia Agricultural Statistics, Bulletin #28. National Agricultural Statistics Service.
4. USDA Dairy 2002, Part II: Changes in the United States Dairy Industry, 1991-2002, Jun 2003.
5. New York State Cattle Health Assurance Program [Online]. Available: http://nyschap.vet.cornell.edu/. Accessed June 2005.
6. Anonymous. Dairy Grade A Voluntary HACCP NCIMS Dairy HACCP Program [Online]. Available: http://vm.cfsan.fda.gov/~comm/nacmcfp.html#princ Accessed June 2005
7. Pennsylvania Dairy Quality Assurance Program [Online]. Available: http://www.agriculture.state.pa.us/agriculture/cwp/view.asp?a=3&q=127865 Accessed June 2005.
8. California Dairy Quality Assurance Program [Online]. Available: http://www.cdqa.org/ Accessed June 2005.
9. Sanbower, K.R. 1983. Large Dairy Operations in West Virginia 1970-1983. Master's Thesis, West Virginia University, Morgantown, WV.
10. Rodrigues, A. C. O., D. Z. Caraviello, and P. L. Ruegg. 2005. Management of Wisconsin Dairy Herds Enrolled in Milk Quality Teams. J. Dairy Sci. 88: 2660-2671.

11. Sheaffer, R.B., Jr. 1993. West Virginia Dairy Farmers' Use of Computers for Dairy Operations. Master's Thesis, West Virginia University, Morgantown, WV.
12. Rodrigues, A. C. O. and P. L. Ruegg 2005. Actions and Outcomes of Wisconsin Dairy Farms Completing Milk Quality Teams. J. Dairy Sci. 88: 2672-2680.
13. Morris, C. E. 1998. HACCP Under the Microscope. 10/01/2000 [Online]. Available: http://www.foodengineeringmag.com/CDA/ArticleInformation/coverstory/BNPCoverStoryItem/0,6326,95670,00.html Accessed June 2005.
14. Morris, C. E. 1998. Multiple interventions to reduce microbiological contamination lead to continuous improvement of food safety. [Online]. Available: www.foodengineeringmag.com/CDA/ArticleInformation/features/BNP__Features__Item/0,6330,95486,00.html - 40k - Accessed June 2005.
15. Sischo W. M., N.E. Kiernan, C.M. Burns, and L.I. Byler. 1997. Implementing a Quality Assurance Program Using a Risk Assessment Tool on Dairy Operations. J. Dairy Sci. 80:777-787.
16. Cullor, J. S. 1997. HACCP (Hazard Analysis Critical Control Points): Is it coming to the dairy? J. Dairy Sci. 80:3449–3452.
17. Ruegg, P. L. 2003. Practical Food Safety Interventions for Dairy Production J Dairy Sci, July 1, 2003; 86(13_suppl): E1 - 9.
18. Heggum, C. 2001. Trends in hygiene management—the dairy sector example. Food Control 12:241–246.
19. NAHMS. 1997. Johne's Disease on U.S. Dairy operations. USDA:APHIS:VS,CEAH, National Animal Health Monitoring System. Fort Collins, CO. #N245.1097.
20. Johne's Information Center [Online]. Available: www.vetmed.wisc.edu/pbs/johnes. Accessed June 2005.
21. European Commission report, March 2000. Possible links between Crohn's disease and paratuberculosis [Online]. Available: http://europa.eu.int/comm/food/fs/sc/scah/out38_en.pdf Accessed June 2005.
22. Zoonotic Potential[Online]. Available: http://www.johnes.org/zoonotic/index.html. Accessed June 2005.
23. Smith, G. C., J. B. Morgan, J. D. Tatum, C. C. Kukay, M. T. Smith, T. D. Schnell, and G. G. Hilton. 1994. Opportunities for enhancing value and improving the quality of beef. Pages 1–10 in The Executive Summary of the National Non-Fed Beef Quality Audit - Special Section: Dairy Cattle. Colorado State Univ., Ft. Collins, CO.
24. Valeeva, N. I., M. P. M. Meuwissen, A. G. J. M. O. Lansink, and R. B. M. Huirne. 2005. Improving Food Safety Within the Dairy Chain: An Application of Conjoint Analysis. J Dairy Sci 88(4): 1601 - 1612. http://www.dairy-science.org/cgi/data/88/4/1601/DC1/1 Accessed June 2005.
25. Lievaart, J.J., J.P.T.M. Noordhuizen, E. van Beek, C. van der Beek, A. van Risp, J. Schenkel and J. van Veersen. 2005. The Hazard Analysis Critical Point's (HACCP) concept as applied to some chemical, physical and microbiological contaminants of milk and dairy farms. Veterinary Quarterly 27(1):21-29.

26. Rogers, C. A., A. C. Fitzgerald, M. A. Carr, B. R. Covey, J. D. Thomas and M. L. Looper 2005. On-Farm Management Decisions to Improve Beef Quality of Market Dairy Cows J. Dairy Sci. 87:1558-1564.
27. Roeber, D.L., P.D. Mies, C.D. Smith, K.E. Belk, T.G. Field, J.D. Tatum, J.A. Scanga and G.C. Smith. 2001b. National Market Cow and Bull Beef Quality Audit—1999. A survey of producer-related defects in market cows and bulls. J. Anim. Sci. 79:658-665.
28. FSIS. 2000. National residue data, "*The Red Book*". Food Safety and Inspection Service - United States Department of Agriculture. [Online]. Available: http://www.fsis.usda.gov/OPHS/red2000/. Accessed June 2005.
29. AVMA Professional Liability Insurance Trust. 1993. Quality Assurance Programs Receive Thumbs Up from Insurance Trust. Journal of the American Veterinary Medical Association 203 (7): 914.

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